THOR-FLX / HIIIr Introduction

1.1 Introduction

For several years the National Highway Traffic Safety Administration (NHTSA) has actively supported the development of an advanced frontal crash test dummy that incorporates improved biofidelic features and significantly expanded instrumentation. One of the main projects in the past several years has been the design and development of the 50% male dummy known as THOR. This dummy was designed as a test device for whole-body trauma assessment in a variety of occupant restraint environments.

Part of the scope of the THOR project included the development of an advanced lower extremity THOR-LX. The THOR-LX development was driven by the fact that the standard lower extremity used in the Hybrid III dummy does not provide the desired the desired range of motion or joint torque characteristics required to meet the new standards proposed by NHTSA in 1998. In addition, the standard Hybrid III lower leg is only instrumented in the tibia section, and the assessment of injury to the foot and ankle is not possible. In the automobile environment, the interest in the evaluation of lower extremity injuries has recently increased. With the widespread use of seat belts and airbags, more people are surviving the major chest and head trauma only to experience a long recovery period in rehabilitating lower leg injuries.

After the successful development and implementation of the 50% male THOR-LX, NHTSA funded the development of a companion leg which would be sized to fit the small 5% female dummy. This program led to the development of the THOR-FLX (Female Lower Extremity). The THOR-FLX was designed to allow retrofit capabilities with the Hybrid III 5% female dummy. **Figure 1.1** shows a pictures of the completed THOR-FLX / HIIIr unit assembly with the flesh removed for clarity.

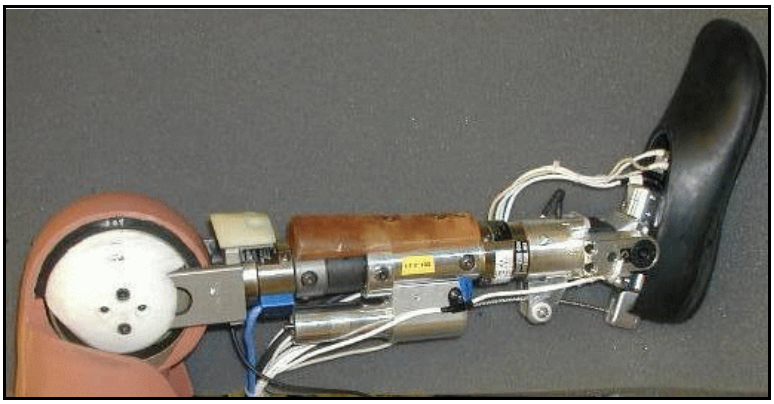

Figure 1.1- THOR-FLX / HIIIr Unit

The mechanical design of the THOR-FLX / HIIIr unit provides several advances over previous lower extremity designs. The leg and ankle response characteristics were scaled from the data sets used to design the 50% male leg. The stock Hybrid III 5% knee housing is used with the updated ball bearing knee slider assembly. A pair of urethane knee covers are attached to

the lateral sides of the knee housing to provide the correct knee profile for knee / bolster interaction. A compliant section was designed into the tibia shaft to provide the correct force transmission from the heel to the knee complex. A spring damper Achilles tendon system was designed to aid in producing the desired ankle motion and torque characteristics. The rotation of the ankle joint about the z-axis (internal and external rotation) has been redesigned to provide a joint torque characteristic which is similar to measured human data. This rotation joint also provides the capability to be locked out for calibration. The new ankle design provides the correct joint axes placement and correct torque vs. angle response for the two primary axes (dorsi / plantar-flexion and inversion / eversion) The range of motion in all three principal directions of rotation was increased to the specifications provided by NHTSA. Soft stop elements were used to provide human-like stiffness at the extremes of motion. The knee, tibia and foot skins were redesigned to be lighter weight and to integrate with the hardware. The mechanical elements of the THOR-FLX / HIIIr design can be seen in **Figure 1.2**.

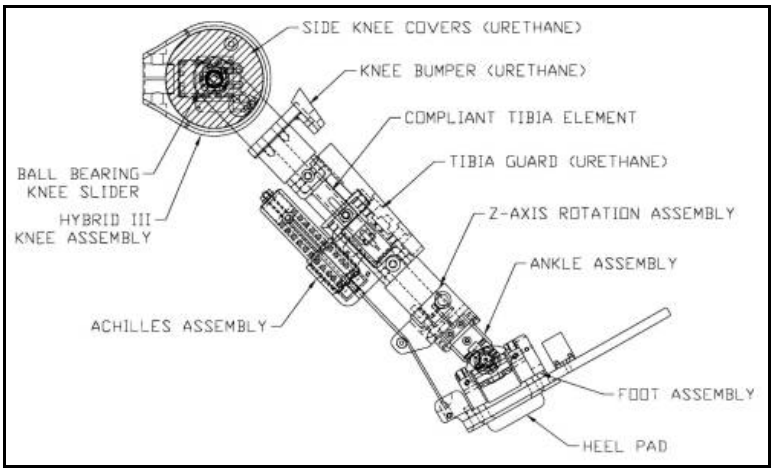

Figure 1.2 - THOR-FLX / HIIIr Mechanical Assembly

The THOR-FLX / HIIIr was also updated with many new sensors to increase the ability of the dummy to measure injury and trauma. Robert Denton Inc. designed a pair of tibia load cells to measure the force and moment data for the tibia shaft. (The upper tibia load cell is a four channel unit, while the lower one provides five channel capability). These tibia load cells are significantly lighter than the standard Hybrid III cells, thus producing more biofidelic inertial and mass properties. Three rotary potentiometers were used to measure the rotation of the individual ankle joints, thereby providing complete kinematic data. A pair of uniaxial accelerometers on the tibia shaft provide the acceleration in the X and Y axes to allow the transformation of the measured tibia moment to the calculated ankle moment. Finally, a triaxial accelerometer array on the foot was included to enable correlation with prior foot / ankle injury tolerance studies. The instrumentation in the THOR-FLX / HIIIr unit is depicted in **Figure 1.3.**

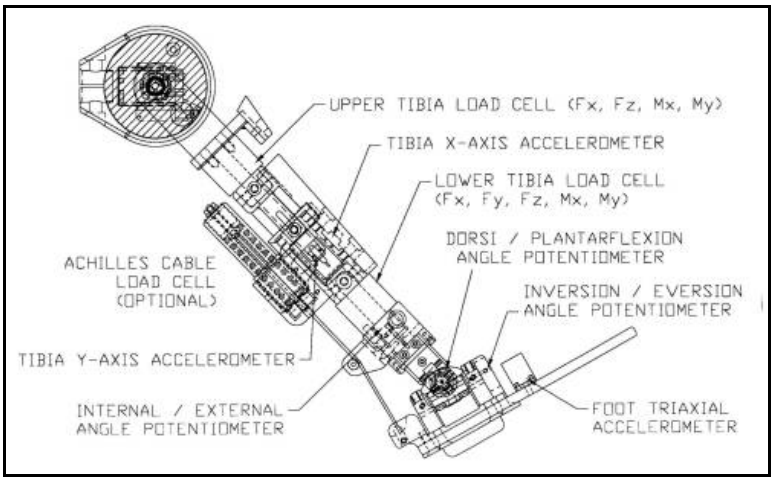

Figure 1.3 - THOR-FLX / HIIIr Instrumentation

1.2 Getting Familiar with the User s Manual

This manual is designed to serve as a reference book for technical people working with the THOR-FLX / HIIIr assembly. The assembly of the THOR-FLX / HIIIr has been described in great detail to assist the technical personnel in the proper set-up and adjustment of the unit for testing. The user s manual has been divided into four sections, as outlined below:

Introduction
General Preparation and Use
Lower Extremity
Instrumentation

1.2.1 Section Organization

Each section of this manual has been divided into the following subsections to provide a complete overview of each assembly.

Description of Features
Assembly of Component or Assembly
Parts List
Assembly Procedure
Assembly of Component onto Dummy
Adjustments
Wire Routing and Electrical Connections
Calibration
Inspection and Repairs

The assembly section of the manual assumes that the components have been disassembled to inspect or service the instrumentation or wear items. This assembly procedure is not designed for a complete strip-down of the component. Please refer to the THOR-FLX / HIIIr drawing package for details which are not covered in this section of the user s manual.

1.2.2 Conventions used Throughout this Manual

Right-hand and Left-Hand

The references to the right-hand and left-hand side of a component or assembly are made with the assumption that the component is installed within the dummy. Reference is made as if the laboratory personnel is oriented in the same position as the test dummy.

Front and Back

The references to front and back refer to the anterior and posterior aspects of the part or assembly based on the dummy reference system.

Top and Bottom

The reference to top and bottom refer to the superior and inferior aspects of the part or assembly based on the dummy reference system.

Dummy Coordinate System

All references made to the coordinate system of X, Y, and Z will be based on the SAE Information Report J1733 - Sign Convention for Vehicle Crash Testing. This SAE sign convention is provided below:

+X is toward the Anterior aspect or front of the dummy
+Y is laterally toward the right
+ Z is toward the inferior aspect or bottom of the dummy